**Magnets, Electromagnets, and Neutrino Beams – LESSON PLAN**

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| Lesson # 3 | **Title of Lesson:** Magnetic Interactions: May the Force Be with You |
| Overview  Standard(s)  & Objectives | **Overview:** This lesson has two components dealing with magnets. The first is to view a variety of different types of magnets to see that size is not always the best indicator of strength when dealing with permanent magnets.  The second part of the activity involves measuring and comparing strengths of two different types of permanent magnets (4 of each) and showing that with a chart or graph.  **Standards**:  3-PS2-2: Make observations and/or measurements of an object’s motion to provide evidence for how a pattern can be used to predict future motion.  (SEP:3, DCI: PS2.A; CCC: Patterns)  3-PS2-3: Ask questions about cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. (SEP: 1; DCI: PS2.B; CCC: Cause/Effect)  5-PSI-3: Make observations and measurements to identify materials based on their properties. (SEP: 3; DCI: PS1.A; CCC: Scale/Properties)  **Objectives:**  Students will understand that different types of permanent magnets have different strengths (not necessarily related to size)  Students will understand that magnets can repel, attract, move other objects. |
| Background  Information | Content for teacher  Permanent magnets  Magnets attract ferrous materials (materials made of iron, nickel, cobalt)  Rare earth magnets are stronger than other permanent magnets.  Magnets and Motors from Smithsonian <https://books.google.com/books?id=B0QrAAAAYAAJ&pg=PA15&source=gbs_selected_pages&cad=2#v=onepage&q&f=false>  pp.8- |
| Materials | Each pair/Group of 4 needs:   * Assortment of magnets: refrigerator magnets, business card magnets, rare earth magnets (super magnets from an office supply store or hardware store), Bucky Balls, magnetic blocks, etc.   Each Student:   * Inference/Evidence Chart (to glue/attach in science notebook)   Comparing Strengths of Magnets Activity Supplies  (adapted from Magnets and Motors from the Smithsonian/The National Academies)   * Chart: Strengths of Different Magnet Combinations * 25 washers USS standard number 10   Each student:   * Science Notebook * Handouts   Each pair/Group of 4 needs:   * 4 flexible magnets (25 x 20 x 5 mm) (1x ¾ x 2/16 inches) with a 5mm hole in middle * 4 super magnets (rare earth) * 2 plastic cups (same size) * 1 wide tongue depressor * 1 jumbo paper clip * 25 washers USS standard number 10 * (If washers are unavailable, use smaller paper clips as a measure) |
| Prior Knowledge | Students will understand that magnets attract ferrous materials. (Day 2 activity) |
| Launch | |
| Engagement and Communication of Student  Expectations | HOOK:  True or False: The bigger the magnet the stronger it is.  Challenge students to determine a way to determine strength of magnets using the materials supplied.  Come up with a way to graph your results.  Today students will play with an assortment of different magnets to determine that size is not the only consideration for strength. They will then further investigate strengths of magnets by determining a way to measure strength of two different types of magnets while varying the number used.  Students will explore various magnets and learn that when it comes to permanent magnets, sometimes size does not always matter. Rare earth magnets (such as super magnets found in office stores) are more powerful.  Students will assess the strength of different combinations of magnets and graph results.  Students will use different types of magnets to demonstrate magnets can attract/repel at a distance and through different materials.  Students will use magnetic force to hold ferrous materials and compare strength of various magnets.  Students will draw conclusions about magnetic force based on evidence.  Students will graph |
| Explore (Time=40-50 minutes) | |
| Procedure | If you do not have an assortment of magnets per group, then students could be given 15 minutes to play with the different magnets as they pay attention to the differing strengths. Are all permanent magnets the same strength? Why or why not?  Explain the procedures for getting materials and expectations for how to return materials. It can be helpful to designate one person responsible to gather materials and make sure all are returned.  Think about how magnets are used in your daily life. How could magnets be used to keep a door closed?  Are magnets used with anything you might use in your daily life? Anything you might play with? |
| Questions  Observable  Unobservable  What ifs? | **Questions for Student Exploration:**  **Observable:**  Can magnets initiate movement?  If so, what types?  What happens when you hold the ends of magnets together?  What factor(s) determine(s) the strength of a permanent magnet?  **Unobservable:**  Can you think of where magnets that you cannot see might interact in your daily life? (refrigerator doors, cabinet doors, purses, etc.)  **Teacher Tips:**  This task can be completed in two parts if an assortment of different magnets is unavailable per group. The first would be an exploration of various types of magnets to demonstrate that there a variety and that size is not always the main factor in strength. This can be set up as a station that kids rotate through in small groups throughout the hour of science or another time during the day. The Inference/Evidence chart can be used.  The second part is looking at strengths of magnets while compiling data to be placed in either a bar or line graph.  While students are conducting the activity, the teacher circulates among the various groups to find good examples for sharing.  Kids may be choosing different ways to solve the same problem. There is no one answer. Be careful not to tell students what to do. Let them grapple with it as a group. If they say, “I don’t know.” Respond with, “If you did know then what would you do?”  If you have a magnetic white board you can use permanent magnets to hold up instructions, time sheets, sample charts, etc. and see if students make any connections.  Students will be given materials and asked to design a fair test for magnetic strength using the materials. (Teacher Background: p. 8 has an example in link below)  <https://books.google.com/books?id=B0QrAAAAYAAJ&pg=PA15&source=gbs_selected_pages&cad=2#v=onepage&q&f=false>  Extension: |
| Summarize (Time =) | |
| Communicate | Discuss as group what was discovered during the activities. Solicit responses from all groups. If one group starts to develop a concept, lead with the question: Who can build upon Group X’s thinking?  Remind students that if they disagree with a group’s point, they have to use respectful language. Teach them to use the stem: I disagree with you because\_\_\_\_\_\_\_\_\_\_\_\_. Be sure to support your claim with evidence from your experiment.  If something you noted while circling the room was not covered, solicit that group to share. Alternatively, you can give post it’s to kids while you are circulating in the room for them to share later. |
| Terminology and Concepts to Solidify | Vocabulary:   * Permanent magnet- a magnet that always has a magnetic force and attracts certain types of metals. * Repel- push away. * Attract- pull towards * Poles-ends of magnets   Concepts:   * When dealing with magnets the material the magnet is made out of may be more important than the size. * Opposites attract: north pole is attracted to the south pole of another magnet. * Permanent magnets attract metals containing iron, nickel, and cobalt. * Permanent magnets may be stronger if they are larger, they are made of rare earth materials, or there are more.   Permanent magnets may attract objects through other materials (tongue depressor, paper, etc.)  The material a magnet is made of is more important than the size when it comes to magnetic strength. |
| Connection  to Big Ideas (Phenomena) | Magnets can be used to attract and/or repel, hold, or move objects.This will relate to the motor concept of the anchoring event. |
| Follow Up/Practice | READING ACTIVITY:  Magnet Reading:  <http://www.myschoolhouse.com/courses/O/1/33.asp>  Read Earth the Magnet. (prior to next lesson)  <http://www.explainthatstuff.com/magnetism.html> |
| Assessment | Formative Assessment:   * Magnetic Sketch Handout * Strength of Magnets Handout * Inference Evidence Chart |

**INFERENCE/EVIDENCE CHART**

**I claim\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**

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| **Inference (I claim…)** | **Observation/Evidence(…because…)** |
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Magnet Exploration--Sketch

Demonstrate what you learned about magnets in a labeled sketch. Then explain your sketch using the following terms: **permanent magnet, north pole, south pole, repel, attract, move, force.**

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What do you think would happen if you put these ends of the magnets together ?  
Be sure to explain your thinking. (I claim \_\_\_\_\_\_\_\_\_\_ because\_\_\_\_\_\_\_\_\_\_\_\_\_\_.)

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**STRENGTHS OF DIFFERENT MAGNETS**

**In the space below, create a graph showing the results you found during the exploration of magnetic strengths. Be sure to label your X and Y axis.**

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